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CHARLESTON, SOUTH CAROLINA AIR QUALITY MAINTENANCE PLANNING AND ANALYSIS

ANNEX: ANALYSIS OF INDUSTRIAL PROCESS FUGITIVE EMISSIONS

U.S. ENVIRONMENTAL PROTECTION AGENCY
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16. ABSTRACT

In a report published earlier (EPA 904/9-77-013), the results of air quality dispersion modeling for Charleston, South Carolina were presented. To improve these results, additional modeling was done using data for industrial process fugitive particulate emissions. Including these emission estimates was shown to significantly improve the modeling results. Sensitivity analysis of the emissions estimates was used to obtain a probable range of emissions estimates. The Air Quality Display Model (AQDM) was the model used.

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ANNEX

ANALYSIS OF INDUSTRIAL PROCESS FUGITIVE EMISSIONS

In an earlier effort, area and point sources of particulate emissions in Charleston, South Carolina were modeled using Air Quality Display Model (AQDM). Seven monitoring sites were used in this earlier analysis to calibrate the model. Predicted air quality compared well with observed TSP concentrations at all but two of these monitoring sites: Meeting Street - Pittsburgh Avenue and State Ports Authority. A major conclusion of that effort was that these two sites were being influenced by substantial low level sources near each site. An inspection program was undertaken to identify and quantify fugitive emissions from industrial sources that might be responsible for high TSP concentrations at these two sites.

EMISSIONS

The inspection reports from this effort were reviewed to identify sources and emissions not included in the original modeling effort. Reports were available for the W. R. Grace Co., Koppers Co., Etiwan Fertilizer, Ford's Redi-Mix, Bird & Sons, Airco Alloys, State Ports Authority (a grain elevator not previously included in the point source inventory), Charleston Naval Shipyard, and Westvaco. Estimates of fugitive emissions were included in the reports for W. R. Grace Co., Koppers Co., Airco Alloys, and Westvaco. For the other plants, fugitive emission sources were identified and process throughputs given. Emission factors from Technical Guidance for Control of Industrial Process Fugitive Emissions (EPA Publication No. 450/3-77-010) were used to estimate emissions from these sources. A summary of emissions by plant and by source is given in Table 1. In addition, a 100 ton per year area source northwest of the Meeting Street - Pittsburgh Avenue site was modeled to obtain possible contributions from unpaved roads in that area upon the monitor.

TABLE 1

INDUSTRIAL PROCESS FUGITIVE EMISSIONS

IN CHARLESTON, SOUTH CAROLINA

PLANT	SOURCE	EMISSIONS (TONS/YEAR)
W. R. Grace Co.[1]	Loading NSP	11
	Screening NSP	2
	Conveying and storing NSP	1
	Second loading NSP	5
	Bagging NSP	4
	Bulk loading NSP	8
	Yard traffic	0.6
	Total	31.6
Koppers Co.[1]	Lumber milling	--
	Yard traffic	10
	Total	10
Etiwan Fertilizer	Unloading fertilizer	16
	Screening and bagging[2]	--
	Total	16
Ford's Redi-Mix[2]		--
Swift Agricultural Chemicals[3]		--
Birds & Sons	Storage piles[4]	29
	Yard traffic[2]	--
	Total	29
Airco Alloys[1]	Open Emission Sources	
	Ore unloading	20
	Ore storage	79
	Crushing, batching & delivery to the furnace	39
	Product screening	4
	ESP dust disposal	16
	Total	158
	Building Vent Emission Sources	
	Tapping	33
	Pouring & cooling	127
	Slag storate	13
	Bed breaking	4
	Total	181

TABLE 1 (CONTINUED)

INDUSTRIAL PROCESS FUGITIVE EMISSIONS

IN CHARLESTON, SOUTH CAROLINA

PLANT	SOURCE	EMISSIONS (TONS/YEAR)
State Ports Authority[1] (Grain Elevator)	Elevated Sources	
	Grain cleaning & screening	142
	Grain drying	58
	Transfer & conveying	57
	Total	257
	Ground Level Sources	
	Truck unloading	78
	Railcar unloading	22
	Ship loading	209
	Rail loading	9
	Vehicle movement	12
	Yard traffic	42
	Total	372
Charleston Naval Shipyard[2]		--
Westvaco[1]	Dowtherm heaters[5]	1.5
	Spray dryers[5]	16
	Yard traffic[6]	7
	Total	24.5

1 Emissions estimates from "Source Inspections in Selected Region IV Non-Attainment Areas to Determine Capabilities of Reducing TSP Emissions".

2 No estimates made because of lack of data.

3 Plant shut down.

4 Estimated using throughputs from inspection reports and emission factors from Technical Guidance for Control of Industrial Process Fugitive Emissions (EPA-450/3-77-010).

5 Should be included in point source inventory.

6 Estimate not based on best emission factor. Using a better factor, the estimate would be less than 1 ton per year.

INITIAL MODELING RESULTS

These industrial process fugitive particulate emissions (IPFPE) were modeled using AQDM. The contributions from IPFPE were manually added to contributions from previously modeled emissions. The same meteorological data as used before were used to model these sources. The emissions at Airco were divided into open and building vent emissions. The emissions from the grain elevator at the State Ports Authority were divided into ground level emissions and elevated emissions. A release height of 100 ft. was used for the building vent emissions at Alloy and the elevated emissions at the State Ports Authority grain elevator. The release height used for the other sources was 10 feet unless similar sources in the point source inventory had higher heights. The additional emissions at Westvaco were not included because most of these emissions were from Dowtherm heaters and spray driers which should be included in the point source inventory. The estimate of yard traffic emissions at Westvaco (7 tons per year) was determined using the unpaved road emission factor even though all plant roads are paved. An independent estimate, using an emission factor developed for paved roads, was 0.38 tons per year. Because of this discrepancy, yard emissions at Westvaco were not modeled. An area of one (1.0) square kilometers was assigned to each fugitive source except that an area of two (2.0) square kilometers was used for the unpaved roads northwest of the Meeting Street - Pittsburgh Avenue site.

Table 2 gives the concentration at each monitoring site which could be attributable to fugitive emission sources. The contributions range from 1 $\mu g/m^3$ to 24 $\mu g/m^3$. In order to compare these contributions to those from other types of sources, see Table 3.

A regression analysis was performed for the new modeling results. The resulting linear regression equation was:

$$Y = -10.872 + 1.959X$$

The correlation index (R^2) was 0.827. This equation represents an improvement over the original regression equation in that the Y-intercept was

TABLE 2

SOURCE CONTRIBUTIONS TO MONITORING SITES
FROM FUGITIVE EMISSIONS[1]
(MICROGRAMS PER CUBIC METER)

MONITORING STATION	INDUSTRIAL PROCESS FUGITIVE EMISSION SOURCES									
	W. R. GRACE	KOPPERS	ETIWAN	BIRD & SONS	AIRCO OPEN	AIRCO BLDG.	SPA GRND.	SPA ELEV.	UNPVD. RDS.	TOTAL
Bushy Park	0.1	-	-	-	0.3	0.3	1.2	0.8	0.2	2.9
Charleston Health Dept.	0.2	0.1	0.1	-	0.8	0.9	0.7	0.5	0.5	3.7
James Island	0.1	-	-	0.1	0.3	0.4	0.6	0.4	0.2	2.1
Mount Pleasant	-	-	-	-	0.1	0.1	0.3	0.2	0.1	0.9
Jenkins Street	0.1	-	-	0.1	0.3	0.4	3.9	2.6	0.2	7.7
Meeting St.- Pitts. Ave.	0.7	0.3	0.2	0.1	5.0	3.1	1.2	0.8	3.1	14.5
State Ports Authority	0.1	-	-	0.1	0.4	0.4	18.6	3.7	0.2	23.5

[1] All values are annual arithmetic averages.

TABLE 3

SOURCE CONTRIBUTION TO MONITORING STATIONS
FROM SELECTED SOURCE TYPES[1]
(MICROGRAMS PER CUBIC METER)

		TYPES OF SOURCES			
MONITORING STATIONS	OBSERVED CONCENTRATIONS	FUGITIVE SOURCES	POINT AND AREA SRCS	UNPAVED[2] ROADS	PAVED[2] ROADS
Bushy Park	48	3	27	16	3
Charleston Health Dept.	53	4	40	15	9
James Island	48	2	29	15	4
Mount Pleasant	37	1	23	14	2
Jenkins Street	57	8	40	15	6
Meeting St.-Pitts. Ave.	106	15	51	14	8
State Ports Authority	90	24	53	16	6

1 All values are annual arithmetic averages.

2 The emissions for paved and unpaved roads were adjusted.

reduced and the slope was brought nearer to 1.00. Yet, the results are still unsatisfactory because of the negative Y-intercept and the large slope.

SENSITIVITY ANALYSIS

The emissions estimates for industrial process fugitive emissions are far from exact. Most of the emission factors are rated D or E on a scale of A-E with E being the least accurate factors. In addition, known fugitive emission sources, such as yard traffic, are still missing from the inventory. Thus, there is considerable latitude for testing the sensitivity of the TSP concentrations predicted by AQDM to revisions in the industrial process fugitive emission estimates. Similar analyses have proven useful in the past for adjusting emission estimates for paved and unpaved roads. Usually, such adjustments can significantly improve calibration results.

Because of the significant gradient in predicted concentrations between the various monitoring stations, it was felt that a sensitivity analysis might provide some useful insights into the TSP attainment problem in Charleston. A number of regression analyses were performed with varying multipliers of fugitive emissions estimates. Table A-4 shows the results of these analyses.

As can be seen from this table, the regression coefficients can be significantly improved if the fugitive emission estimates are increased. In this case, quadrupling the emissions at Airco may be unsupportable based upon the inspection reports because reasonable emission factors appear to have been used. Yet, these estimates still do not include emissions from yard traffic. In the original effort, no emissions for unpaved roads were estimated for this area. The 100 tons per year used in this modeling exercise was an arbitrary value. No data exists to indicate that the emissions from unpaved roads could not be 400 tons per year. For the grain elevator, the emissions were calculated using emission factors in the middle of the broad range of factors. Were one to use the highest values in the range, the emissions estimates would be doubled. Although it appears reasonable that the actual emissions could be greater than those estimated, there is no conclusive evidence that they are.

TABLE 4

RESULTS OF SENSITIVITY ANALYSES

ANALYSIS CONDITION	Y-INTERCEPT	SLOPE	CORRELATION INDEX
Double all fugitive emission estimates	9.007	1.175	0.839
Triple all fugitive emission estimates	18.470	0.821	0.826
Multiply all fugitive emission estimates by a factor of 2.5	14.482	0.967	0.839
Double only the emissions for Airco and the unpaved roads near Meeting St.-Pitts. Ave.	-5.266	1.699	0.916
Triple only the emissions for Airco and the unpaved roads near Meeting St.-Pitts. Ave.	1.916	1.428	0.927
Triple the emissions for Airco and the unpaved roads near Meeting St.-Pitts. Ave. and double the emissions from the SPA grain elevator	8.934	1.137	0.920
Quadruple the emissions for Airco and the unpaved roads near Meeting St.-Pitts. Ave. and double the emissions from the SPA grain elevator	10.962	1.041	0.964

CONCLUSIONS AND RECOMMENDATIONS

The following conclusions can be drawn from this analysis of industrial process fugitive emissions in Charleston, South Carolina:

1. Substantial improvements in calibration can be achieved by including estimates of industrial process fugitive emissions.
2. The TSP nonattainment problem in Charleston is limited to an area near the monitoring sites at Meeting Street and Pittsburgh Avenue and at the State Ports Authority. The violations may be primarily due to indistrial process fugitive emissions in the area. Yet, these emissions still are not adequately quantified. (The recommendations for quantifying these emissions which were given in the earlier report are still the best approach.)
3. If certain assumptions are made concerning the emission levels of certain fugitive sources, the AQDM can be calibrated for Charleston, South Carolina.

Based upon these conclusions, it is recommended that DHEC continue to investigate methods for controlling industrial process fugitive emissions in Charleston. Further efforts to quantify these fugitive emissions could also prove useful to DHEC. Nothing in this analysis contradicts the earlier conclusions and recommendations.

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CHARLESTON, SOUTH CAROLINA AIR QUALITY MAINTENANCE PLANNING AND ANALYSIS ANNEX: ANALYSIS OF INDUSTRIAL PROCESS FUGITIVE EMISSIONS

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